Pursuing the green nudge premium? Analyzing discontinuities of Energy Performance Certificates in the French housing market.

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Labels against Lemons

- Products of uncertain quality could be unfairly valued by economic agents, due to information asymmetries (Akerlof, 1970). Today information failures on products' quality plague the development of eco-friendly consumption (Cason and Gangadharan, 2002)
  - Labels and certificates have acquired popularity among policy-makers, firms and NGOs.
- Energy Performance Certificates spread in the European Union as an answer to the energy-efficiency gap (Jaffe and Stavins, 1994): home appliances, vehicles and buildings.
- Mandatory in every French real estate transaction since a decade.

Literature

1. Hedonic approaches have demonstrated premiums for labelled energy-efficient houses,
   - In the United States, LEED and EnergyStar certifications induce a green premium for labelled buildings (Eicholtz et al., 2010).
   - In the European Union, hedonic analyzes of the EPC premiums over several countries: 3.7% in the Netherlands (Brounen and Kok, 2011), 9% in Ireland (Hyland et al., 2013), similar to England (Fuerst et al., 2015).
   - In France, Civel (2019) estimates the premium for highly efficient houses around 30k€.

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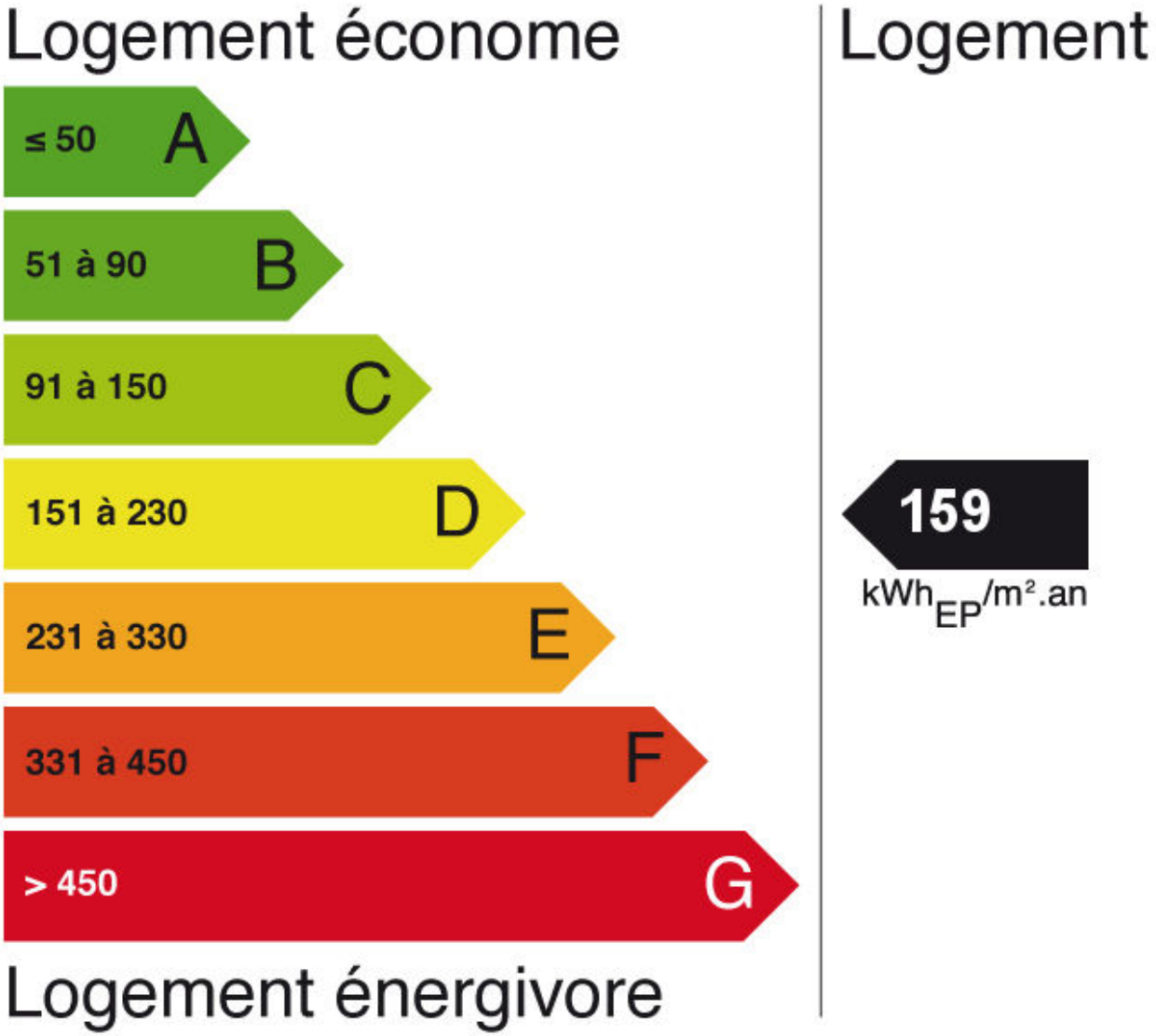
   - In France, Civel (2019) estimates the premium for highly efficient houses around 30k€.
2. But is this premium really derived from the label?
   - Can't be sure with classical hedonic analysis,
   - Olaussen et al. (2017) on norvegian data tend to demonstrate that people might be able to estimate by themselves energy performance and not use EPC.

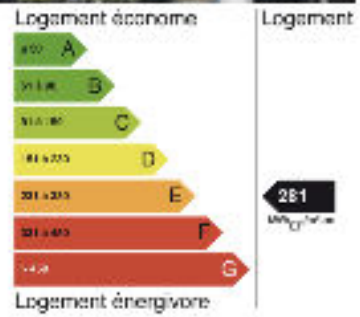
Energy Performance Certificate



Energy Performance Certificate on real estate ad

Maison 105 m^2, deux étages, 8 pièces, à proximité du centre-ville de Landerneau, 274 300 €

Charmante maison traditionnelle au rez-de-jardin donnant sur une ruelle piétonne. Belle pièce de vie lumineuse de 45 m^2, avec cheminée, exposée sud/ouest. Deux étages distribuant 4 chambres et 2 salles de bains avec WC séparés. Cuisine attenante entièrement équipée. Bureau à l'entresol. Huisseries alu double vitrage, chauffage au gaz. Garage et possibilité d'achat d'un terrain de 950 m^2.



Present paper originality

Our specificities

1. Use of a very large data set of French real estate transactions, from 2014 to 2022, throughout the country,
2. Estimation of the green premiums at EPC class frontiers through regression discontinuity design,
3. Analysis of certifiers behaviors.

Data preparation

- EPC database with 3.5 millions observations,
- Real estate transaction database with 4.5 millions observations.

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- Real estate transaction database with 4.5 millions observations.
- Fused using geographic coordinates,
- Little challenging as GIS were not synchronized,
- Final clean database counts over 1.5 millions observations, which descriptive statistics closely match the ones of original databases, selection bias is probably low.

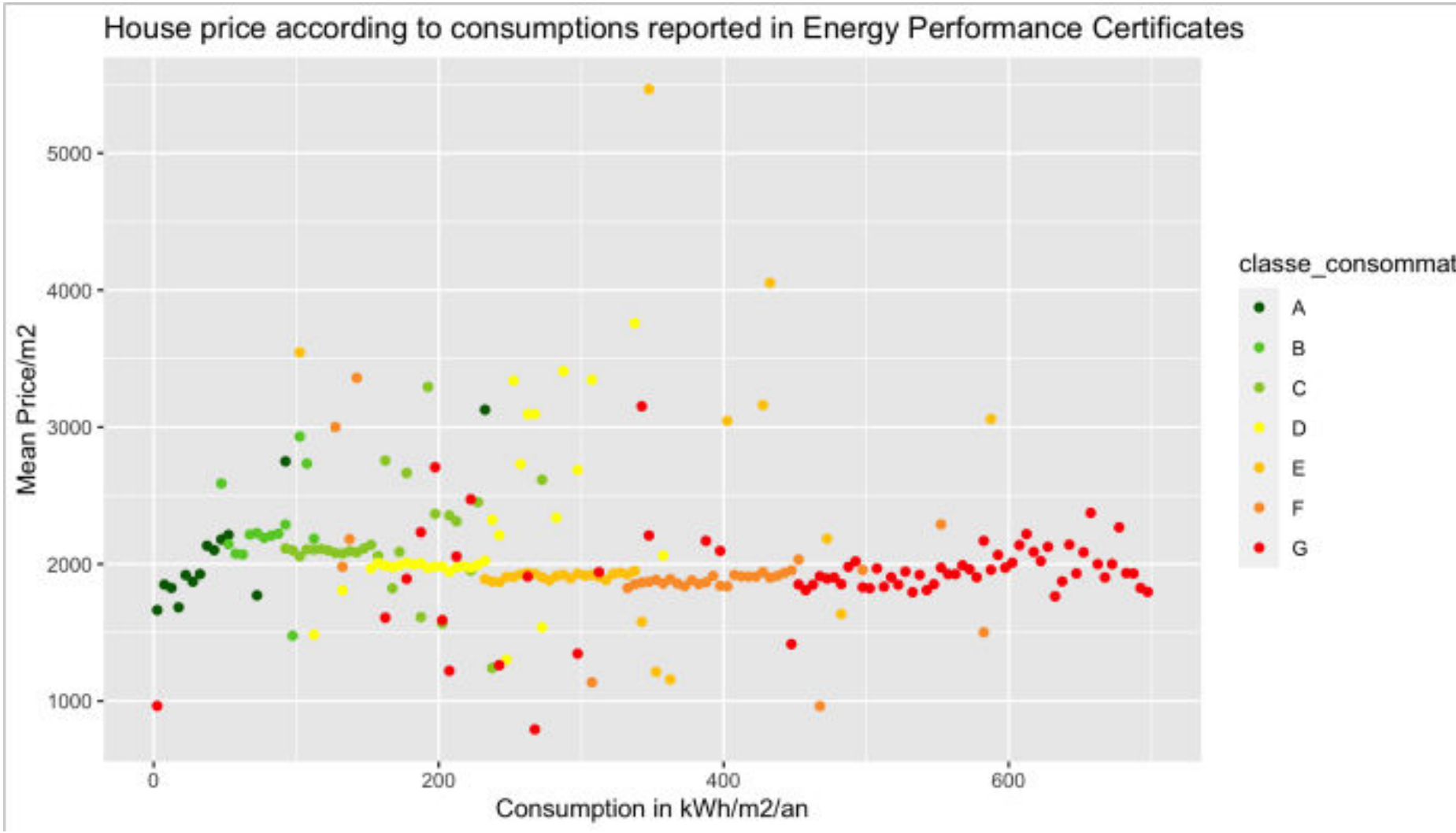
Fused database houses

EPC Class	A	B	C	D	E	F	G
Count	16,974	33,954	135,877	277,722	216,280	87,407	25,254
Mean Price	237,123	277,961	305,026	266,020	262,040	195,352	293,664
Mean Area	114	161	121	110	98	87	75
Mean Land	447	425	405	398	396	392	391
Mean Energy Cons.	41	72	126	194	280	385	531
Median Constr. Year	2016	2010	1982	1974	1969	1960	1955

Hedonic analysis

	Dependent variable:
	Natural logarithm of property value
Label A	0.064^{***} (0.007)
Label B	0.101^{***} (0.004)
Label C	0.107^{***} (0.002)
Label D	0.076^{***} (0.002)
Label E	0.037^{***} (0.002)
Label F	Reference
Label G	-0.036^{***} (0.004)
House characteristics Var.	Yes
Year FE	Yes
Departement FE	Yes
Zipcode FE	Yes
Observations	460,725
R^2	0.643
Adjusted R^2	0.642
Residual Std. Error	0.371 (df = 459176)
F Statistic	533.700^{***} (df = 1548; 459176)
Note:	*p<0.1; **p<0.05; ***p<0.01

Mean house prices = f(Energy consumption)

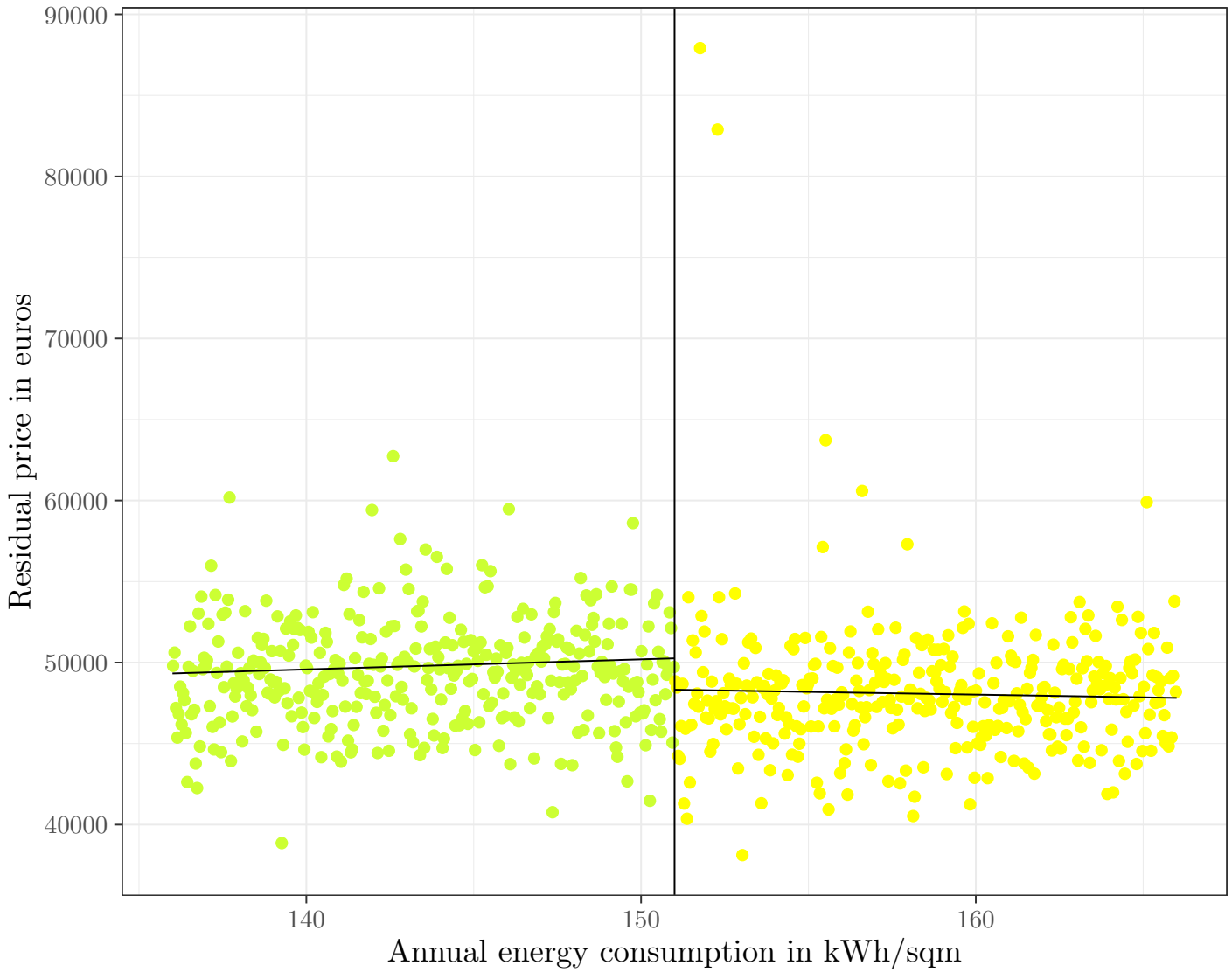


Regression Discontinuity Design - RDD

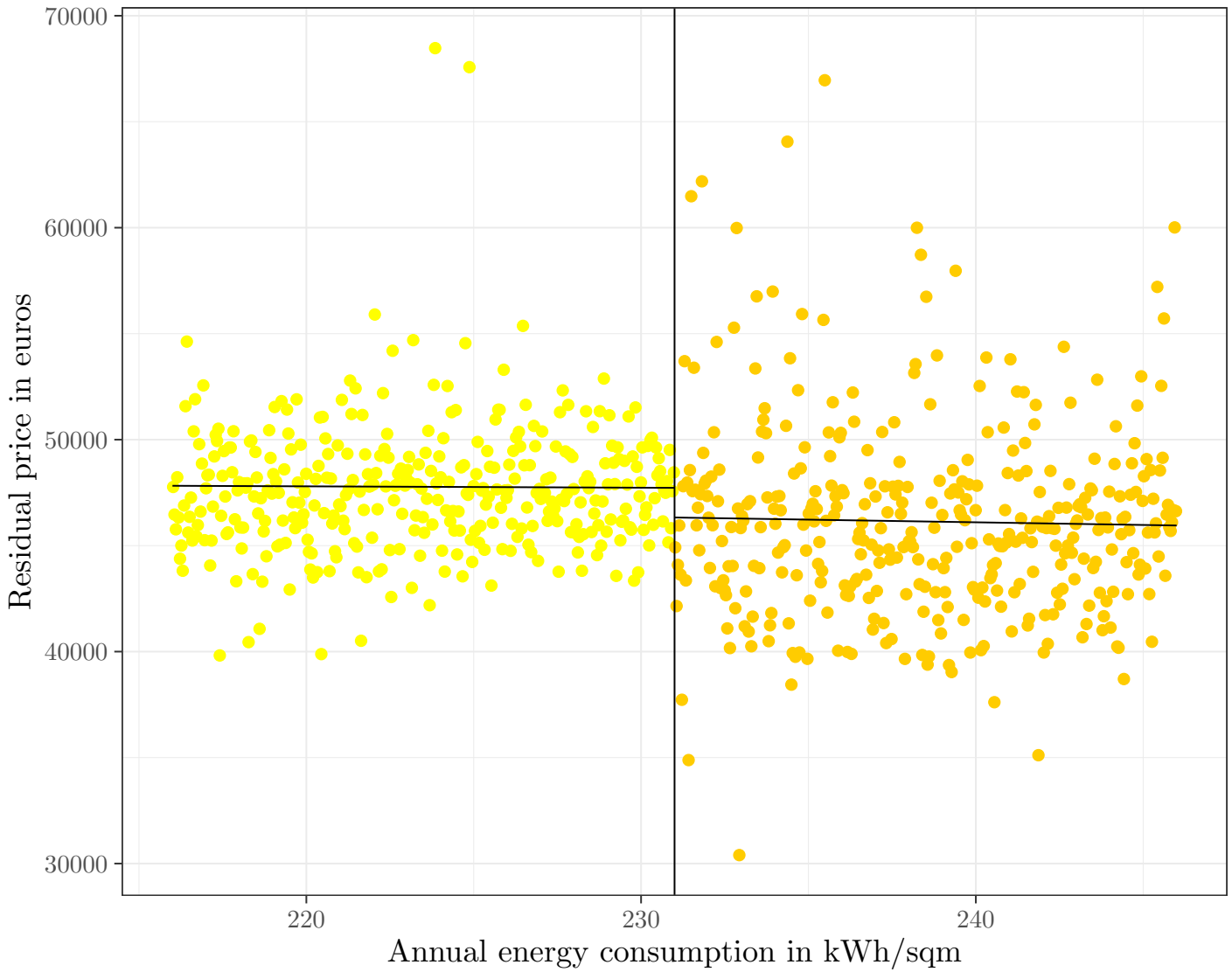
RDD, in its basic setup, relies on three elements: a **running variable**, a **cutoff** and a **treatment**.

1. Two subsets of subjects are allocated to experimental and treatment groups as a function of an independent variable — the running variable.
2. Subjects with running variables that exceed a certain threshold (or inversely, fall below it), will receive an experimental treatment.
3. The boundary value of the running variable that determines the group status is referred to as cutoff.

RDD in practice - Zoom on C/D frontier



RDD in practice - Zoom on D/E frontier



RDD results show high significance at cutoffs

Table XVI: The effect of DPE on the real estate market in France in 2014-2020. Regression discontinuity analysis under manipulation. Houses

Cutoff	RD Estimate	p-value		95% Rob. C.I.		Bandwidth		Nb. of obs.	
		Standard	Robust			Left	Right	Left	Right
51	-319.80	0.8705	0.8310	-5110.72	4107.20	10.1	10.1	367	831
91	891.98	0.1724	0.3102	-722.11	2272.82	11.9	11.9	3946	6900
151	1996.72***	0.0001	0.0001	1197.76	2933.05	21.8	21.8	26706	27460
231	1471.48***	0.0001	0.0001	770.76	2161.82	28.4	28.4	48050	25306
331	2505.08***	0.0001	0.0001	1632.27	3720.55	27.6	27.6	23092	9597
450	655.57	0.3618	0.6507	-1324.33	2120.10	59.0	59.0	13172	4001
51	83.87	0.9645	0.9479	-4176.34	4464.34	12.8	8.5	417	651
91	1253.60**	0.0498	0.1055	-260.48	2733.05	9.8	17.1	3418	10935
151	2011.18***	0.0001	0.0001	1017.68	2980.48	15.6	19.0	20289	23575
231	1453.96***	0.0001	0.0001	722.50	2093.74	21.0	29.4	36997	26264
331	2548.92***	0.0001	0.0001	1641.88	3800.40	29.9	25.7	24794	8914
450	876.63	0.1631	0.3094	-744.79	2349.65	50.4	82.3	10978	5138
51	-565.82	0.7259	0.9743	-5029.61	4866.93	15.0	15.0	458	1309
91	980.35	0.1000	0.3591	-856.40	2362.73	15.0	15.0	4668	9011
151	1935.28***	0.0001	0.0547	-27.28	2759.52	15.0	15.0	19342	18364
231	1399.68***	0.0007	0.0144	302.17	2732.04	15.0	15.0	28251	12091
331	3518.70***	0.0001	0.0001	2852.36	5770.81	15.0	15.0	13196	4955
450	-2779.04*	0.0702	0.0207	-9057.21	-747.84	15.0	15.0	3204	1205

Notes: RD estimate per dwelling sold. Local weighted linear regression. Weights applied using triangular kernel function. $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$

RDD and placebo cutoffs

Table XIV: RD Analysis for DPE class Cutoffs and Placebo Cutoffs. Houses

Cutoff	Bandw.	RD Estimate	Robust p-value	Robust C.I.		Nb of obs.
5	2.4	-2450.63	0.955	[-21776.55 ,	23070.63]	32
25	5.8	4656.64	0.408	[-7765.78 ,	19109.32]	141
51	10.1	-319.80	0.831	[-5110.72 ,	4107.20]	1198
85	9.4	461.08	0.407	[-1004.70 ,	2478.84]	6735
91	11.9	891.98	0.311	[-722.11 ,	2272.82]	10846
125	11.9	-196.82	0.818	[-1760.37 ,	1390.07]	22802
151	21.8	1996.72***	0.001	[1197.76 ,	2933.05]	54166
185	6.1	-493.66	0.503	[1636.35 ,	803.18]	16513
205	6.9	-942.46*	0.064	[-2317.93 ,	66.50]	18742
231	28.4	1471.48***	0.001	[770.76 ,	2161.82]	73356
245	9.6	-358.16	0.684	[-2047.87 ,	1344.02]	17771
285	5.4	549.69	0.474	[-1603.76 ,	3452.92]	9543
305	8.1	-397.45	0.533	[-2174.36 ,	1125.07]	13135
331	27.6	2505.08***	0.001	[1632.27 ,	3720.55]	32689
365	22.7	607.55	0.442	[-970.72 ,	2225.65]	15073
425	18.3	495.46	0.637	[-1145.59 ,	1870.84]	7809
450	59.0	655.57	0.651	[-1324.33 ,	2120.10]	17173
485	10.4	898.94	0.504	[-2211.35 ,	4502.25]	1448
525	8.2	-996.15	0.557	[-6386.54 ,	3438.77]	737
565	15.3	-2502.08	0.241	[-7070.88 ,	1776.38]	875
605	9.0	-1089.83	0.700	[-9332.28 ,	6267.70]	308
645	10.7	5543.42	0.283	[-5838.21 ,	19996.11]	252
685	4.1	1928.77	0.413	[-4834.25 ,	11774.52]	82

Notes: $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$

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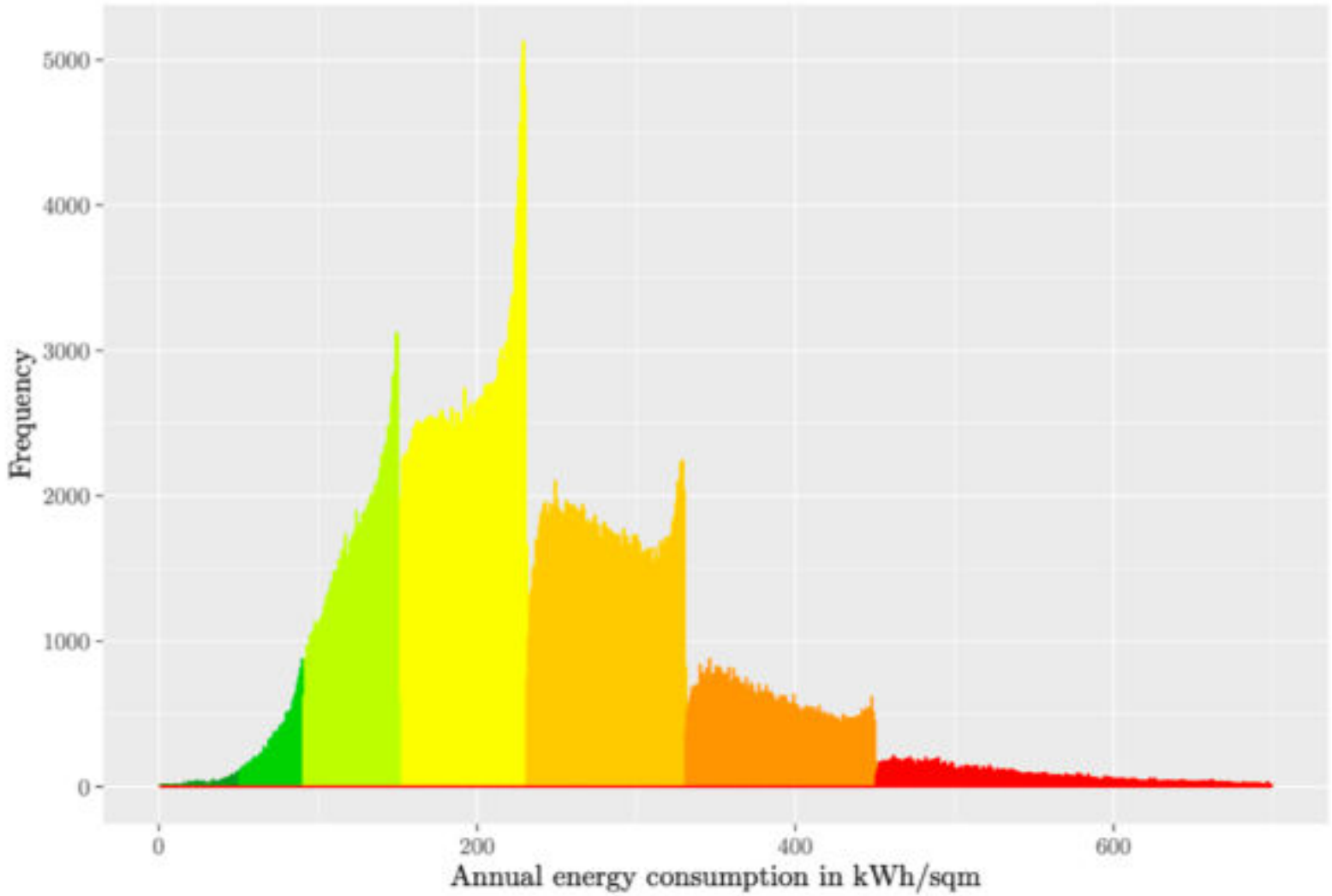
EPCs histogram reveals obvious manipulation



EPCs histogram reveals obvious manipulation

- Discontinuity of the underlying variable raises the question of why and how this manipulation occurs:
  - $\rightarrow$ Observed characteristics of houses/flats do not exhibit discontinuities at EPC cutoffs,
  - $\Rightarrow$ Is the manipulation driven by unobserved characteristics of dwellings, or can it be explained by market effects?

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- RDD results are robust to a donut-hole design, removing observations $5kWh/m^2.year$ above and below cutoffs (the obviously manipulated zone).
- Market effects are thus explored.

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$\Rightarrow$ We exploit the EPC dataset to understand what drives the probability of being just below a cutoff rather than just above.

	Real cutoffs (231 & 331)
EPC method:	
Energy bills (vs Thermal modeling)	−0.183***
	(0.006)
Herfindahl-Hirschman Index	−0.931***
	(0.142)
Certifier experience	0.0001***
	(0.00001)
Heating needs (Dhref/1000)	0.001***
	(0.0003)
Year of certification	−0.012***
	(0.002)
Zone average square-meter price	−0.00002***
	(0.000001)
Dwelling type: House (vs Apartment)	0.083***
	(0.006)
Constant	25.080***
	(3.511)
Observations	227,932
Log Likelihood	−125,780.300
Akaike Inf. Crit.	251,578.500

Note:

	Real cutoffs (231 & 331)	Placebo cutoffs (191 & 281)
EPC method:		
Energy bills (vs Thermal modeling)	−0.183***	0.013**
	(0.006)	(0.006)
Herfindahl-Hirschman Index	−0.931***	0.212
	(0.142)	(0.138)
Certifier experience	0.0001***	0.00003***
	(0.00001)	(0.00001)
Heating needs (Dhref/1000)	0.001***	−0.001***
	(0.0003)	(0.0003)
Year of certification	−0.012***	−0.002
	(0.002)	(0.002)
Zone average square-meter price	−0.00002***	−0.000003*
	(0.000001)	(0.000002)
Dwelling type: House (vs Apartment)	0.083***	−0.005
	(0.006)	(0.006)
Constant	25.080***	3.859
	(3.511)	(3.107)
Observations	227,932	238,931
Log Likelihood	−125,780.300	−165,584.700
Akaike Inf. Crit.	251,578.500	331,187.400
Note:		*p<0.1; **p<0.05; ***p<0.01

Contributions

Main messages & further research

1. Regression Discontinuity Design demonstrates that an insignificant change in houses energy consumption induces a significant one in the market price through a class change in the label, highlighting consumers' heuristic thinking.
2. Certifiers manipulate heavily EPCs at class frontiers, probably in order to gain market shares by using convenient certificates as loss leaders.

Hear it on the grapevine...

Thanks for your attention.